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APPARATUS AND PROCEDURE FOR EXTRACTING CORN ROOTWORM EGGS FROM SOIL

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The northern and western corn rootworms complete one life cycle each year. They oviposit eggs in soil in August and September. The eggs develop slightly, go into a resting stage during the winter, and hatch in the following spring. The potential for damage by the larvae of these insects in the next growing season can be determined by counting the number of eggs per unit of soil. However, it is physically impossible to count these eggs without some means of extracting them from the soil, since rootworm eggs are slightly smaller than the period at the end of this sentence.

Researchers at the University of Missouri (Chandler et al. 1966) developed a machine for separating rootworm eggs from soil. A sample of soil containing eggs is saturated with sodium hypochlorite and water, and the sample is agitated for 15-20 minutes on a ball mill. The sample is then passed in small amounts through a slowly revolving screen cylinder and washed with sprays of water from fixed nozzles and a hand sprayer. The eggs are collected in a fine-mesh screen trap for final processing.

Using the basic design of the Missouri separator, we engineered a larger, enclosed machine that extracts rootworm eggs from a pint of soil in 3-4 minutes. The final stages of separating eggs from debris require another 5 minutes after which the eggs can be counted under a microscope. The Illinois machine and the final separation of eggs, using magnesium sulphate, are highly efficient, and we have repeatedly recovered 97 percent of rootworm eggs manually placed in samples of soil. Weed scientists in the Department of Agronomy, University of Illinois, also have used the machine to extract weed seeds from soil samples in their weed pest-management program.

The Illinois machine is constructed of stainless steel, and all seams are welded watertight. The table top and cabinetry are made of stainless steel sheeting, and the supporting framework is 1/8-inch stainless steel angle frame. The plumbing is connected directly to a domestic water source. An external view of the machine, with dimensions, is shown in Fig. 1.

A soil sample is placed in the sieve insert in the 9-inch diameter funnel beneath the shower head, and the sample is sprayed with full water pressure. The funnel-shaped sieve insert constructed of 30-mesh T-304 stainless steel screen fits inside the funnel with 1-inch clearance between the mesh sieve and the funnel. The wire for the sieve insert has a diameter of 0.01 inch, a mesh opening of 0.023 inch, and a weight of 20 pounds per 100 square feet. Fifty percent of the sieve's surface is open area, allowing an easy, rapid flow of eggs and soil in suspension. The funnel with the sieve in place is shown in Fig. 2. The shower head is controlled by a foot pedal. The plastic garbage can under the machine collects waste water and soil. Residues of soil that cling to the sides of the sieve, the receiving funnel, and the funnel immediately below are flushed down with water sprayed from a common kitchen sink sprayer.

The internal design is illustrated in Fig. 3. A 1/10-horsepower 60-RPM gearmotor, using drive-pulley reduction to 50 RPM, slowly rotates a 50-mesh T-304 stainless steel screen cylinder. The wire for the screen cylinder has a diameter of 0.009 inch and a mesh opening of 0.011 inch,

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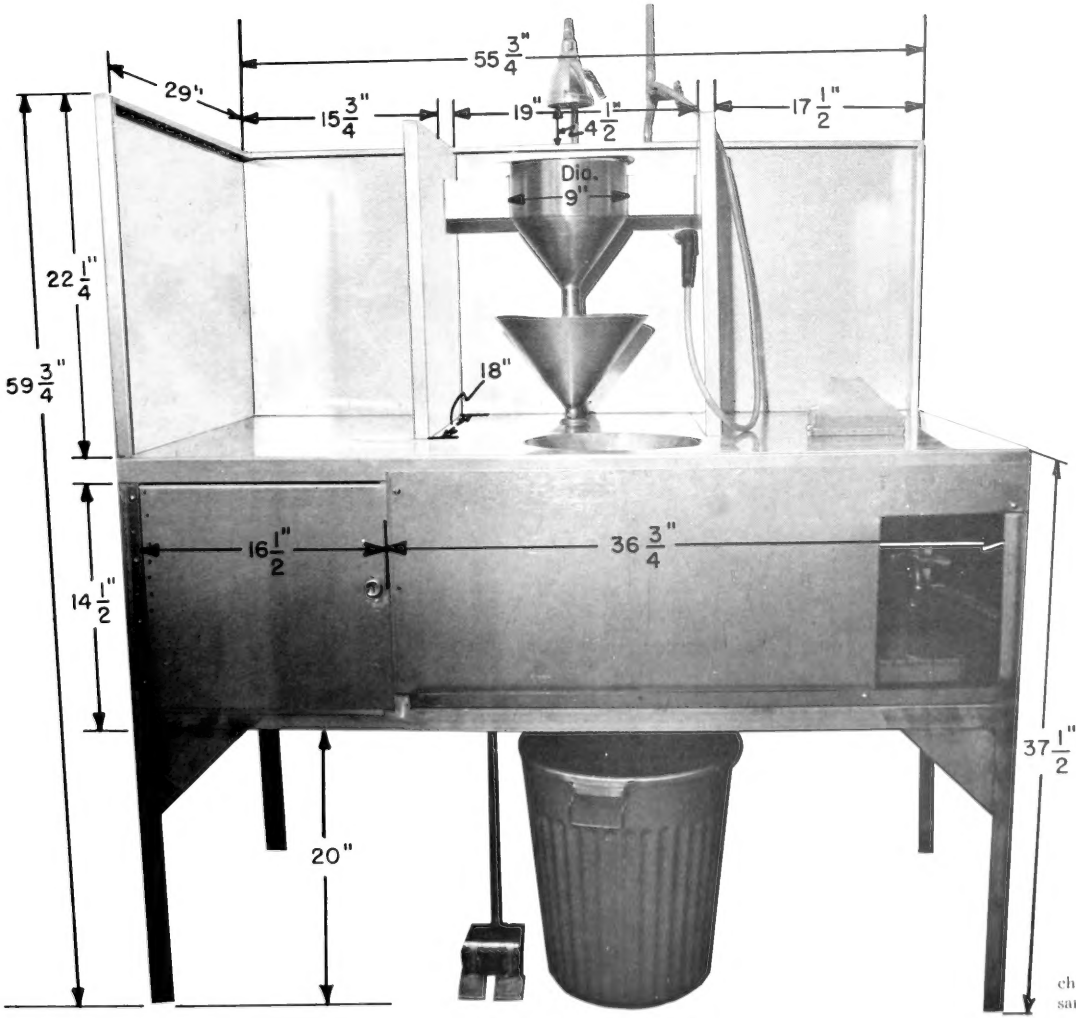

Fig. 1.—External view, with dimensions, of machine used to extract corn rootworm eggs from a sample of soil.

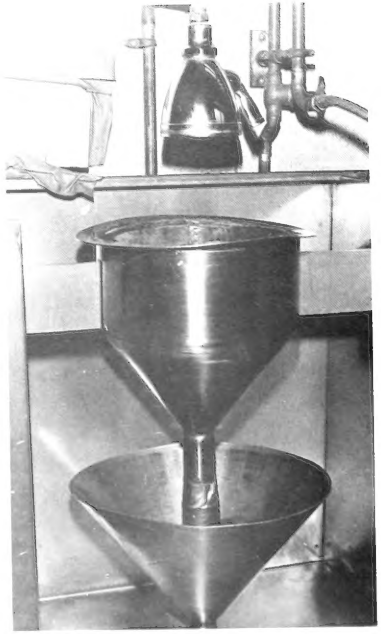

Fig. 2.—Nine-inch diameter funnel with stainless steel sieve insert. A soil sample is placed in the sieve and sprayed with water from the shower head.

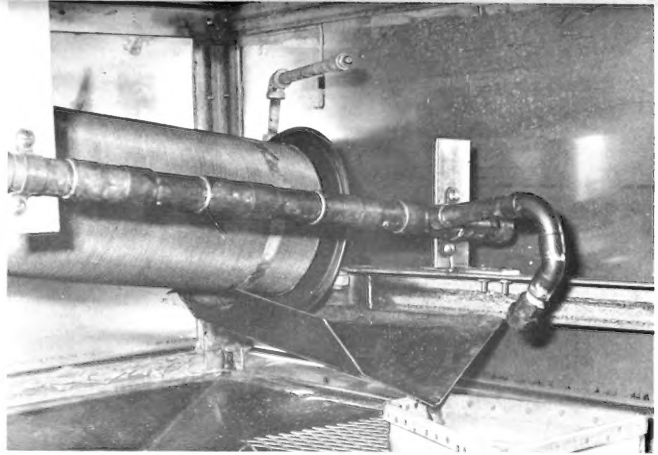

Fig. 4.—Collecting trough and stainless steel screen collecting tray. A nozzle sprays directly into the collecting tray.

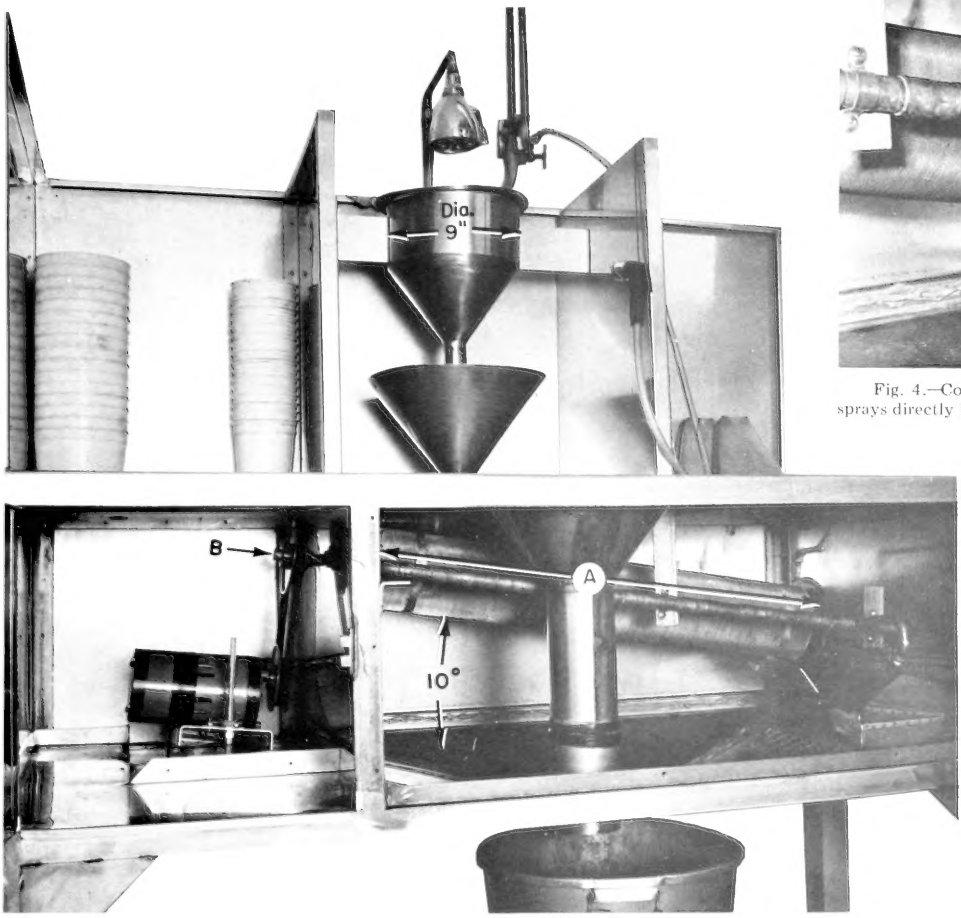

Fig. 3.—Internal design of rootworm egg extracting machine. Stainless steel screen cylinder (A) is 5 inches in diameter and 30 inches long. The screen cylinder and its shaft (B) are sloped 10 degrees.

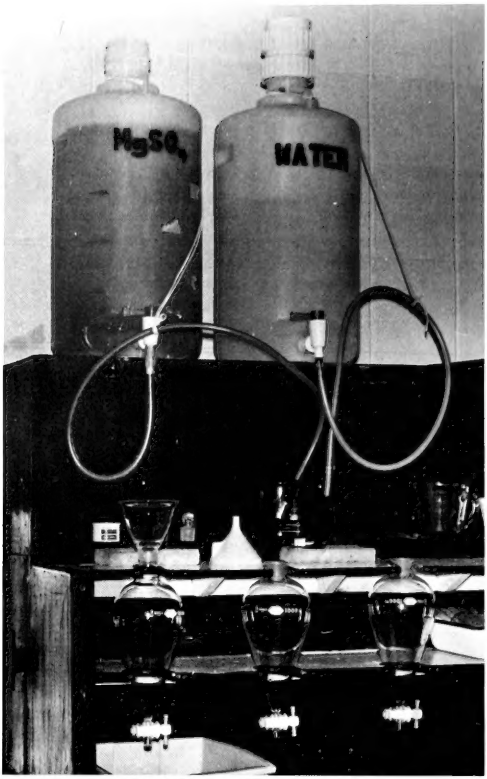

Fig. 5.—Laboratory arrangement for the final separation of corn rootworm eggs from soil. Magnesium sulphate and water flow by gravity into the separatory funnels. The funnels can be removed from the stand.

and 30.3 percent of the screen surface is open area. The wire weight is 28.4 pounds per 100 square feet. The cylinder is 5 inches in diameter and 30 inches long and has a 10-percent slope (the slope is very important). The cylinder is mounted on a 3/4-inch diameter shaft. Seven fan T-jet No. 8004 nozzles mounted both in front of and behind the cylinder spray it with water. If the water pressure is below 35 lb/in^2 at the installation site, special nozzles will be required to compensate for the low pressure. The water containing eggs and soil spills into a trough at the lower end of the cylinder. This trough is slanted toward the front of the machine, causing eggs and soil to drop into a collecting tray constructed of the 50-mesh stainless steel screen used in the cylinder. A nozzle sprays the eggs and debris in the collecting tray. A close-up view of the collecting trough and tray is shown in Fig. 4.

Cleaning the upper surface of the machine is facilitated by a large hole which funnels into the lower unit, and all water and soil is voided through one outlet into the waste container. A stainless steel partition separates the electric motor compartment from that of the screen cylinder, and for safety a steel mesh guard is located in front of the electric motor.

The screen cylinder is the most important unit in this machine. It is geared to turn at 50 RPM. During construction, the seams of the machine must be carefully soldered so that all surfaces are smooth. This is extremely important. The machine will not be reliable if cracks or uneven areas occur in the cylinder. Extra soldering is necessary to fill minute cracks. Careful soldering is also needed for the collecting tray so that all corners are filled with solder and all surfaces are smooth.

Before using the machine, one collects soil in the field, using an acceptable sampling procedure. A sample may be a composite of subsamples or a number of individual samples taken at various locations in a field. The sample is sifted through a 1/4-inch hardware cloth screen and mixed thoroughly. One pint of soil is measured and placed in the sieve in the top funnel under the shower head. The sample is sprayed for 3 minutes and any remaining soil is flushed down with the hand-operated kitchen sprayer. The sample moves through the screen cylinder, and in 3-4 minutes all of the eggs and remaining debris collect in the collecting tray. The collecting tray is then sprayed thoroughly with the hand-operated sprayer.

The collecting tray is removed from the machine, and the eggs and remaining debris are flushed into a 1,000-ml separatory funnel with a stopcock opening of approximately 7mm. See Fig. 5 for the arrangement of equipment for the final processing of corn rootworm eggs. Approximately 500 ml (about 1 pint) of 2 mol magnesium sulphate solution ($MgSO_4$) are used to flush the eggs and debris into the funnel. The funnel is shaken vigorously and returned to the holding rack; in about 30 seconds the heavier debris sinks to the bottom of the funnel. The stopcock is then opened and the debris and about 450 ml of the magnesium sulphate solution are drained from the funnel. Care should be taken not to drain off all of the magnesium sulphate solution, since the eggs will be floating on its surface. The stopcock is closed, 500 ml of water are added to the funnel, and the funnel is shaken again. The sample must settle for no less than 1 minute (this time is critical) to permit the eggs to sink to the bottom of the funnel. Next the stopcock is opened and closed quickly to drain the eggs and about 50 ml of water into a petri dish. The eggs are counted under a binocular microscope, and the number of eggs per pint of soil is recorded. The $MgSO_4$ solution can be reused by straining it through a sieve to remove minor debris.

REFERENCE

CHANDLER, J. H., G. J. MUSICK, and M. L. FAIRCHILD. 1966. Apparatus and procedure for separation of corn rootworm eggs from soil. Journal of Economic Entomology 59:1409-1410.